Available online on 15.07.2019 at http://jddtonline.info

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

Open Access Research Article

A Study on Antibacterial Property of Herbal-Biopolymer Nanoencapsulate Treated Fabric

[1]* Dr. J. Banupriya & [2] Dr. V. Maheshwari

1. Assisstant Professor, Department of Costume Design and Fashion, PSG College of Arts and Science, Coimbatore.
2. Associate professor, Department of Costume Design and Fashion, PSG College of Arts and Science, Coimbatore.

ABSTRACT

The present study deals with the eco-friendly antibacterial finish that has been integrated into bamboo/cotton woven treated fabric in the form of nanocapsules using ethanolic *terminalia chebula, Rosmarinus officinalis* and *Opuntia littoralis* (2:1:2) ratio and Chitosan biopolymer extracts by exhaust method in order to reduce the bacterial growth on the fabric. This herbals-biopolymer extract was evaluated for activity against medically challenging bacteria such as *Staphylococcus aureus* and *Escherichia coli*. The *in-vitro* antibacteria were performed by AATCC 147 for the treated nanoencapsule coated sample. Then the coated sample was analyzed for morphology using FTIR, FESEM and Cytotoxicity test. Thus the study supports the concept of nano encapsulation providing better additional properties to bamboo/cotton fabric and the application of nanotechnology is one of the supreme ways for humanizing the antibacterial activity.

Keywords: Bamboo-Cotton fabric, Nano encapsulation, *Terminalia chebula* extract, *Rosmarinus officinalis, Opuntia littoralis,* Antibacterial finish.

Article Info: Received 18 May 2019; Review Completed 25 June 2019; Accepted 03 July 2019; Available online 15 July 2019

Cite this article as:

Banupriya J, Maheshwari V, A Study on Antibacterial Property of Herbal-Biopolymer Nanoencapsulate Treated Fabric, Journal of Drug Delivery and Therapeutics. 2019; 9(4):433-437 **http://dx.doi.org/10.22270/jddt.v9i4.3204**

***Address for Correspondence:**

Dr. J. Banupriya, Assistant Professor, Department of Costume Design and Fashion, PSG College of Arts and Science, Coimbatore.

1. INTRODUCTION

Bamboo fibers are an environmentally friendly, renewable, degradable fiber. Bamboo fabric is having high demand in the market because of their antibacterial nature, softness, biodegradable properties, high moisture absorption capacity and Ultraviolet Protection capability(1).

Cotton is the most popular and highly used fiber amongst the fibers, hence admired and adopted by the consumers all over the world right from the ancient period of development. Cotton is called as "King of fibers" and is composed of highly preferred conventional and versatile natural cellulosic fiber in the array of the world textile economy. It is known for its fascinating feel, comfort and versatility(2).

Weaving is the oldest and traditional process of manufacturing fabrics. Woven fabrics are classified by the way in which warp and weft cross each other(3). Finishes must be durable and stable in the presence of other chemicals, also should have wash fastness, when applied evenly and consistently. Finishes also need to be financially feasible and environment friendly(4).

Most of the Antimicrobial agents available in the market for the application of textiles are synthetic-based and may not be environmentally friendly. Among the improvement of textile with Antimicrobial finish it is greatly essential and appropriate since garments are in direct contact with human body(5). Natural polymers like chitosan, collagen, sericin, etc., are attracting the attention of researchers because of their availability of resources, low cost, easy handling and minimum damage to the environment.

There were various techniques to impart the functional agents into the fabrics. Encapsulation is one of the new methods of receiving functional finish on textiles. Encapsulation is a micro or nano packaging technique involving deposition of the thin polymeric coating on small particles of solid or liquid(6).

2. MATERIALS AND METHODS

The fabric used for the current study was 30's count bamboo/cotton woven fabric with 50:50 blends. Then the grey sample were immersed in boiling water for 20 minutes and dried to remove the starch and impurities. Then the sample was treated with commercial enzyme (cellulase) with 50 ml of 0.1 M phosphate buffer (PH 7.0) level.

2.1 Collection, Processing and Extraction of herbs

The herbal extract selected for the present study was *terminalia chebula, Rosmarinus officinalis* and *Opuntia littoralis* (2:1:2) ratio which was collected in and around of Coimbatore. The collected dry herbs were shade dried at room temperature to reduce the moisture content. The dried herbs were powdered and sieved. For extraction, (2:1:2) dried herbs ratio with ten grams taken and mixed into 50ml of 80% ethanol. The container was closed and kept overnight. After overnight incubation, the extract was filtered through filter paper and evaporated at room temperature upto 15 ml and concentrate the extract.

2.2 Extraction of Chitosan from shell of the crabs

The crab exoskeletons collected were placed in Ziploc bags and refrigerated overnight. Moisture content was determined on the crab waste by first crushing exoskeletons into smaller pieces using a meat tenderizer. Approximately ten grams of wet samples of crushed crab's exoskeletons were placed on foil paper and measured using a Mettle balance. There were five measurements made of the weight of the wet crushed crab exoskeletons samples. The samples were then labeled and oven-dried for four consecutive days at 65°C until constant weight.

2.3 Nanoparticles preparation from Herbs and biopolymer Extracts

The Nanoparticles were synthesized by using 100 ml of each Chitosan biopolymer and Herbal extracts solvents of the fruit of *Terminalia chebula,* leaves of *Rosmarinus officinalis* and *Opuntia littoralis* (2:1:2) . Initially 250 ml of sodium alginate (base solution) (3.35mg / ml) was prepared, followed by 150 ml of calcium chloride (3 mg / ml) preparation. The calcium chloride ($CaCl_2$) solution was added drop by drop into sodium alginate solution with constant stirring at 1500 revolutions per minute at room temperature for 30 minutes. Then the Herbal extract was added separately to the mixture very carefully drop by drop to the above solution with constant stirring for 45-60 minutes. The mixture was kept undisturbed overnight. After incubation, the uppermost layer was discarded and the pellets were collected and characterized for further research.

2.4 Preparation of Herbs Biopolymer Nanocomposite

In order to synthesize the composite, vortex method was used for the synthesis of Herbs Biopolymer nanocomposite. The mechanical mixing process was appropriate for preparing Herbal Biopolymer nanocomposite. 250 ml of Herbal nanoparticles solution (1% wt./wt. in acetic acid) and 250 ml of Biopolymer nanoparticles solution (1% wt./wt. in water**)** (1:1) were mixed in 1000 ml beaker and stirred for one hour at 60ºC to obtain a homogeneous solution. The speed of the stirrer can be varied as the setup has a speed controller attached to it. To this solution, one milliliter of two percent glutaraldehyde solution in water is added under stirring at room temperature (25ºC). The nanocomposite prepared was subjected to nanoencapsulation.

2.5 Preparation nano encapsulation[8]

The extract was nano encapsulated using bovine albumin fraction as the wall material and herbal powder as the core material. The nano particle enclosed bovine albumin fraction was prepared by cross linking with glutaraldehyde. The extraction was incubated with the required 4% protein solution (W/V) for an hour at room temperature. The pH of the solution was adjusted to 5 .5 by 1M HCL using digital pH meter. Then ethanol was added to the solution in the ratio of 4:1 (V/V). The rate of herbs biopolymer extracts addition was carefully controlled at 1 ml per minute. The coacervate so formed was hardened with 25% glutraldehyde for 2 hours to allow cross-linking of protein. Vacuum evaporator was used to remove the organic solvents under reduced pressure whereafter the nanocapsules were collected and stored.

2.6 Antibacterial assessment of finished bamboo/cotton fabric by (AATCC 147)

15ml of AATCC Bacteriostasis agar media was used to prepare AATCC Bacteriostasis plates by making use of sterile petri plates. The plates were allowed to solidify for 10 minutes and the bacterial culture was inoculated as single line followed by the four lines without refilling the inoculation loop. The bamboo cotton blended bleached finished fabrics were cut into 5 X 2.5 cm size with the diameter of 2.5 cm was placed over the inoculated bacterial species. Then the plates were kept for incubation at 37ºC for 24 hours. At the end of incubation, zone of incubation formed around the fabric was measured in millimeter and recorded.

2.7 Instrumentation

The surface morphology of treated sample was observed in FESEM, FTIR and Cytoxcity wound healing assay was analyzed.

3. RESULTS AND DISCUSSION

3.1 Antibacterial efficacy of Controlled, Nanoencapsulate finished and washed sample

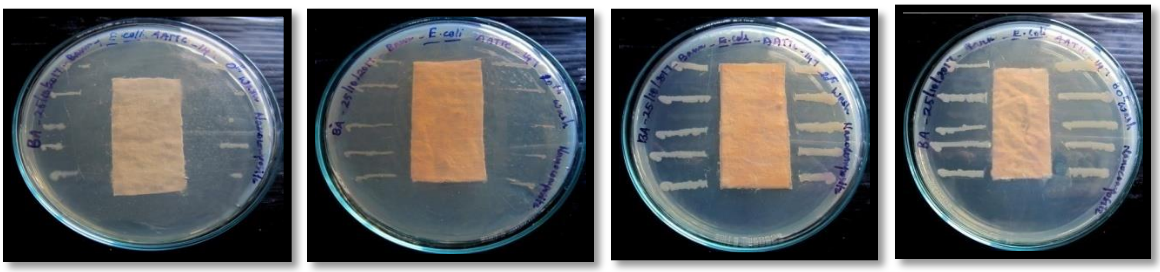
The finished fabric was assessed for the antibacterial activity by AATCC 147 test against *Staphylococcus aureus* and *Escherichia coli* and tabulated in table 1.

Table-1 shows the activity against *Staphylococcus aureus* and *Escherichia coli*

S. no.	Sample	Zone of inhibition (mm)	
		E. coli	*S. aureus*
1	Control sample	0	0
2	Herbs biopolymer nanoencapsule finished fabric	42	44
3	After ten washes	39	40
4	After twenty washes	37	37
5	After thirty washes	32	33

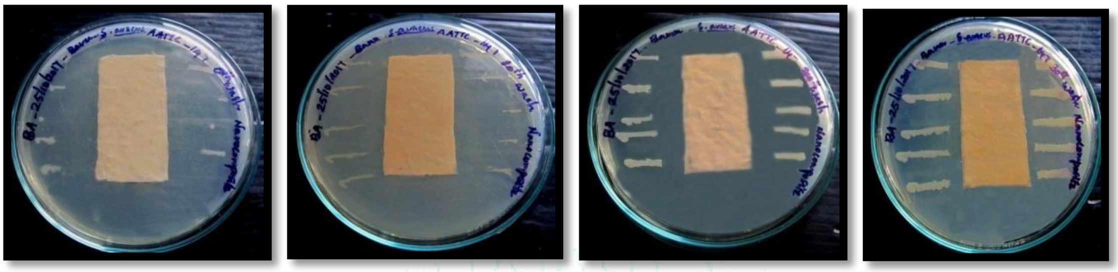
From the assessment, herbs (2:1:2) ratio and chitosan biopolymer nanoencapsulate sample, the treated sample showed good antibacterial property and even after thirty washes the sample showed good zone of inhibition in both *Escherichia coli* and *Staphylococcus aureus.*

Wash durability of the Antibacterial activity of the Nanoencapsulate fabric sample and their 10, 20 and 30 washed samples against *Escherichia coli*



1. Treated Sample **2.** After 10 washes **3.** After 20 washes **4.** After 30 washes

Wash durability of the Antibacterial activity of the Nanoencapsulate fabric sample and their 10, 20 and 30 washed samples against *Staphylococcus aureus*



1. Treated Sample **2.** After 10 washes **3.** After 20 washes **4.** After 30 washes

Plate 1: Antibacterial Activity by AATCC 147

3.2 FTIR and FESEM analysis

The FTIR spectra of nano encapsulate finished fabric is shown in figure-1 and FESEM picture is given in figure 2 and 3.

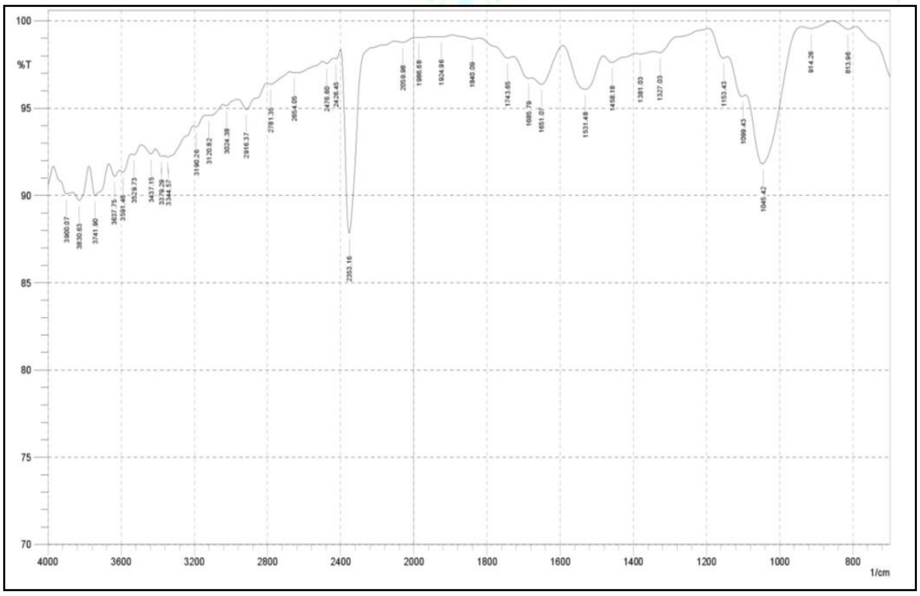
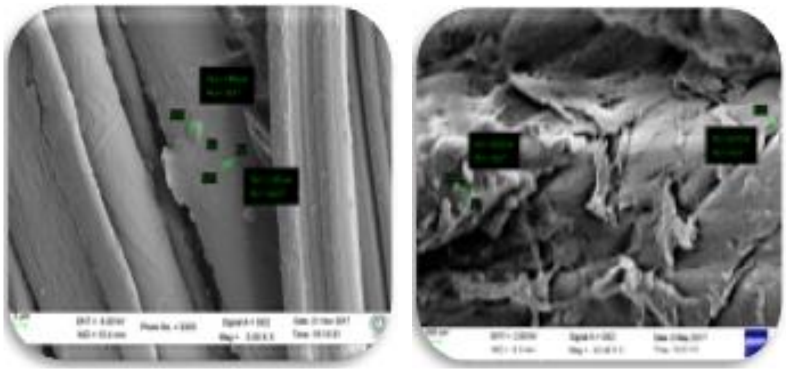


Figure 1 FT-IR analysis of nano encapsulate finished fabric

The FT-IR was adopted to characterize the potential interactions. In the spectra, the FT-IR spectrum was used to discover the functional group of the different components based on the peak value in the area of infrared radiation. The functional group identification is based on the FT-IR peaks attributed to the stretching and bending vibrations. The result of FT-IR analysis revealed the presence of alkenes, esters, aliphatic amines, aromatic amines, alkanes, α,β-unsaturated aldehydes, ketones, aldehydes, nitriles, alkanes, 1°, 2° amines, amides, phenols and nitro compounds.



igure 2 FESEM analysis of nano encapsulate finished fabric

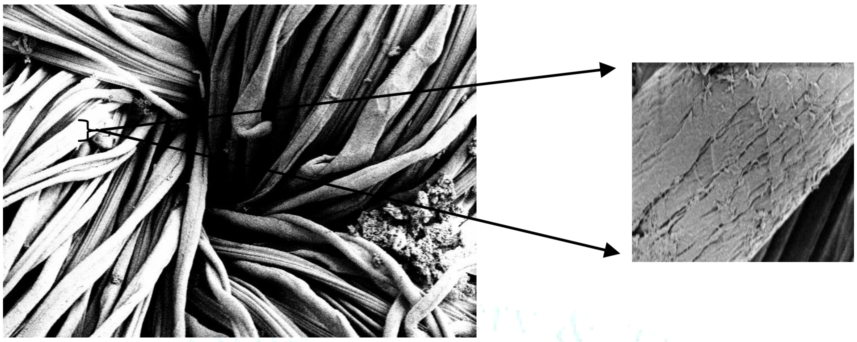


Figure 3 FESEM analysis of untreated fabric

The above figure gives the capsule size falling between 40nm to 90nm and it is firmly attached to the fiber with even distribution with a length of 300nm^2 whereas there is no evidence of the antibacterial property in figure-3 as it represented the untreated fabric.

3.3 Analysis of Wound Healing Assay for Nanocomposite

The wound healing assay for nanocomposite were shown in the Table-2

Table-2: Wound Healing time intervals and percentage

Sample name	Conc. (µl)	Wound area (µm)	Time intervals (h) and percentage of healing		
			0	4	18
Nanocomposite	25	620	Initial Period	19	Healed
	50	720		33	
	75	830		6	20
	100	760		9	23

The cell migration, cell proliferation of L929 fibroblast cell lines and wound closure were measured for a known concentration (100µg) of developed wound healing composite at three different time periods (0th hour, 4th hour and 18th hour). The self-wound healing ability of the composite showed that, at 0th and 4th hour, no cell migration and proliferation were observed including control (Distilled water). At 18th hour, the samples showed positive cell migration and cell proliferation. So the Herbal Biopolymer nano composite showed wound healing in 25 µl with more cell proliferation were evident thus indicating the wound healing ability of the developed composites.

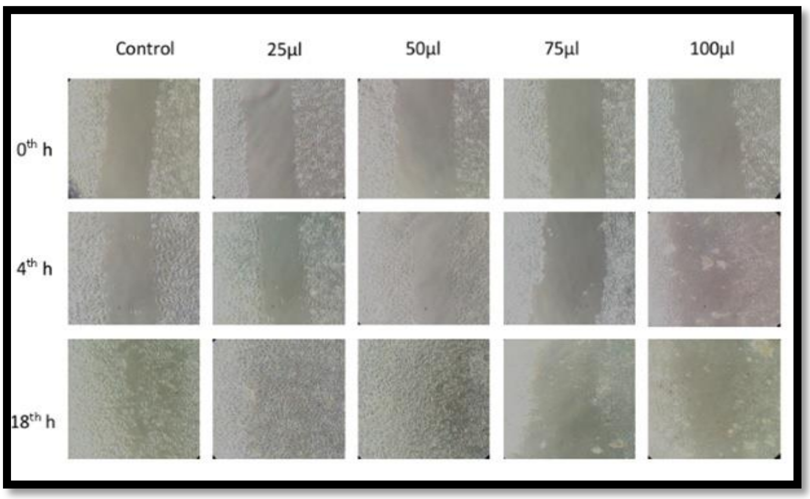


Plate-2: Wound Healing assay for Herbal Chitosan Nanocomposite

4. CONCLUSION

Thus from the findings, the use of this herbal-biopolymer extracts of nano encapsulation treated bamboo/cotton fabric is more apt. This finished fabric shows the maximum antibacterial activity against both *Staphylococcus aureus* and *Escherichia coli.* Nanoencapsulation finished fabric has more durability, when compared with the direct herbal application method. Hence the treated nano encapsulate finished method can be viewed as the suitable method for eco-friendly antibacterial finish.

REFERENCES

1. Zhang Q., Jiang S., Tang Y (2002), "Industrial utilization of bamboo", INBAR Technical Report Pp:26.
2. Malik Prem, (2007), "Role of Cotton as Major Textile Raw Material", Textile Magazine, Vol. 48, No. 4, Pp:12
3. Filiz Sekerden, (2011), "Effect of Fabric Weave and Weft Types on the Characteristics of Bamboo/Cotton Woven Fabric" Fibre& Textiles in Eastern Europe, Vol.19, No. 6(89),Pp:47-52.
4. Wang C., Yediler A., Kiefer F., Wang Z., Kettrup A. (2002). Comparative Studies on the Acute Toxicities of Auxiliary Chemicals Used in Textile Finishing Industry by Bioluminescence Test and Neutral Red Test. Bulletin of Environmental Contamination and Toxicology, 68, Pp:478–484
5. Chawla,.R and Bajwa,.A.A., (2011), Eco-friendly Textiles and Eco labeling essential for survival, Textile Review, Pp:2.
6. Mahesh S., Manjunatha R. & Vijaya Kumar G.(2011). Studies on Antimicrobial Textile Finish Using Certain Plant Natural Products. International Conference on Advances in Biotechnology and Pharmaceutical Sciences (ICABPS'2011) Bangkok Dec., 2011
7. Saleem, A.; Husheem, M.; Härkönen, P.; Pihlaja, K. (2002). "Inhibition of cancer cell growth by crude extract and the phenolics of Terminalia chebula retz. Fruit". Journal of Ethnopharmacology. 81 (3): 327-336. PMID 12127233. doi:10.1016/S0378-8741(02)00099-5.
8. M.Sumithra & N. Vasugi raja (2012), Micro encapsulation and nano encapsulation of denim fabrics with herbal extracts, Indian journal of fiber and textile research, vol.37, pp.321-325